REMEMBER

La physique de LMD dans WRF

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- Challenge: Inclusion of LMDZ (GCM) physics in WRF (LAM)
- Use of WRF primitive-equation dynamics in combination with LMDZ physics

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4. Technical aspects:
   - Minimal changes in LMDZ code
   - Use of WRF compilation structure/framework
5. Usability aspects:
   - Use LMDZ physics as a new WRF set of parameterizations
   - Preserve WRF flexibility and capabilities

Technical differences

- WRF code is very flexible:
  - fully modular: no mixture of dynamics, physics, i/o
  - fully F90 code: pointer, data-structures, namelist, ...
  - all variables, domain dimensions and data is kept in a Fortran data structure called `grid`, which is managed with an ASCII file called `Registry`

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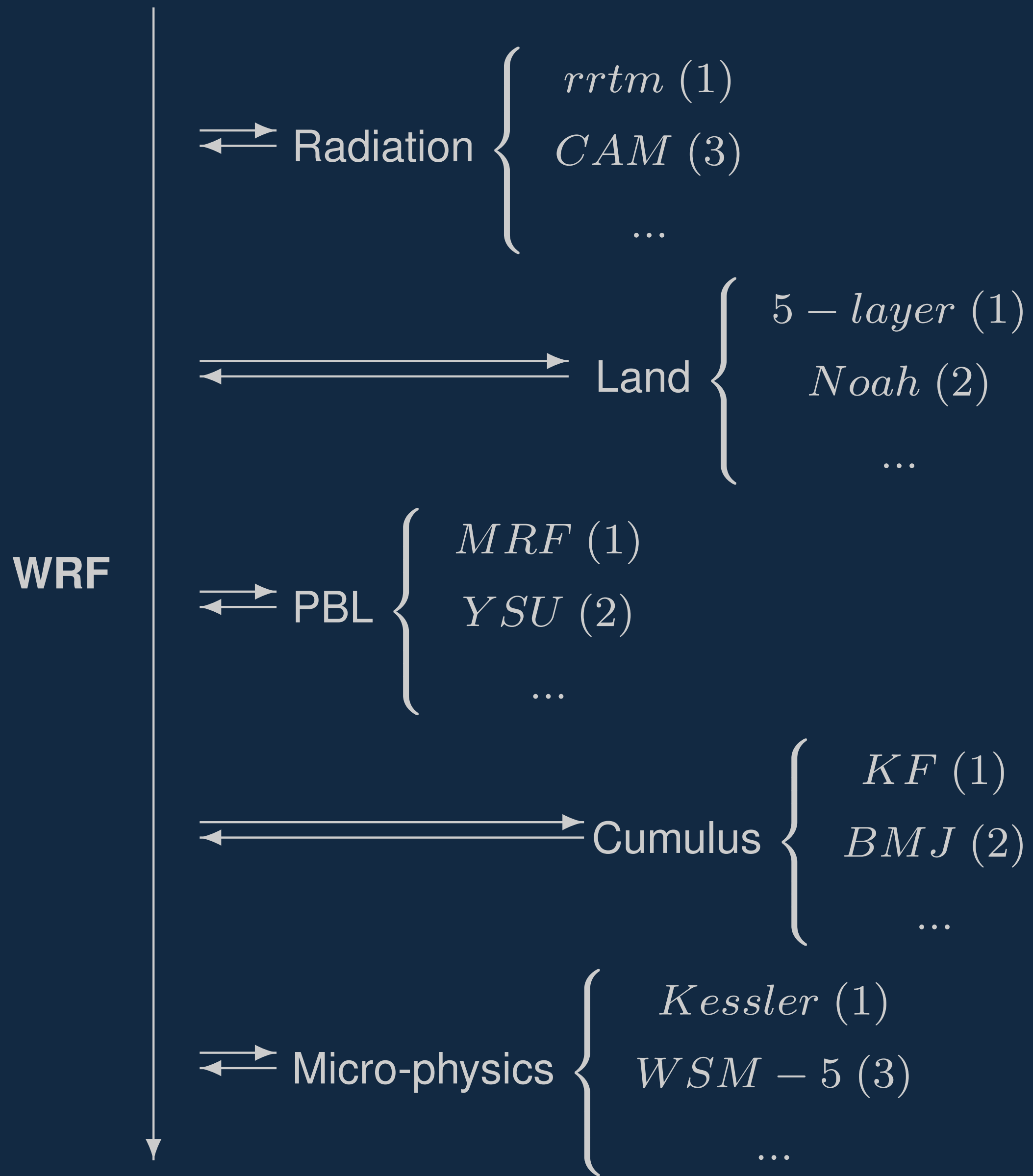
  - all variables, domain dimensions and data is kept in a Fortran data structure called `grid`, which is managed with an ASCII file called `Registry`
- LMDZ code is less flexible:
  - not fully modular: mixture of physics & i/o
  - F77 & F90 code: static grid dimensions, use of ’SAVE’

Models' structure



- Model 'call' each scheme consecutively
- Multiple versions of each scheme
- Flexibility of combination of schemes
- Inconsistent combi-nations!

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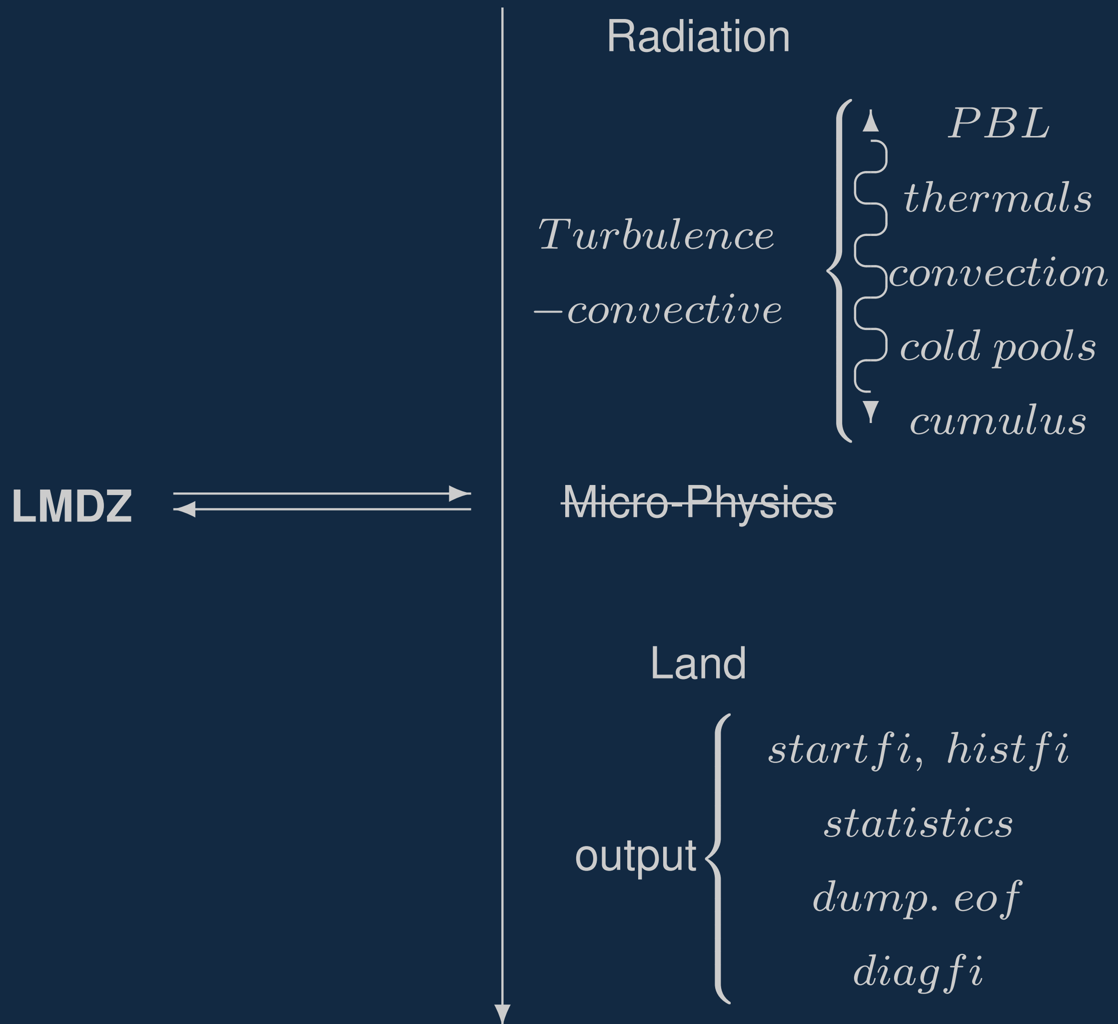

- Robust call of physics schemes
- Computation of climatic values: daily/monthly means
- Single *'turbulence-convective'* scheme

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dyn_em/solve_em.F	physiq.F
$T, U, V, Q, pres, ...$	$\partial_t T, \partial_t U, \partial_t V, \partial_t Q$

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dyn_em/solve_em.F — physiq.F

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- Utilization only of WRF initial and boundary conditions

Work in progress...

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2. LMDZ receiving WRF initial conditions: working
   - Orography variables for the orographic scheme: not done
   - GHG gases? $ozone, CO_2, CH_4, NO_2, CFC-11, CFC-12$, aerosols?: not done nor thought
   - WRF does not support *p_top = 0*. Add an extra vertical level used only by LMDZ? : not done nor thought

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8. couplings with ORCHIDEE, NEMO, INCA: not done nor thought

Regional extreme events

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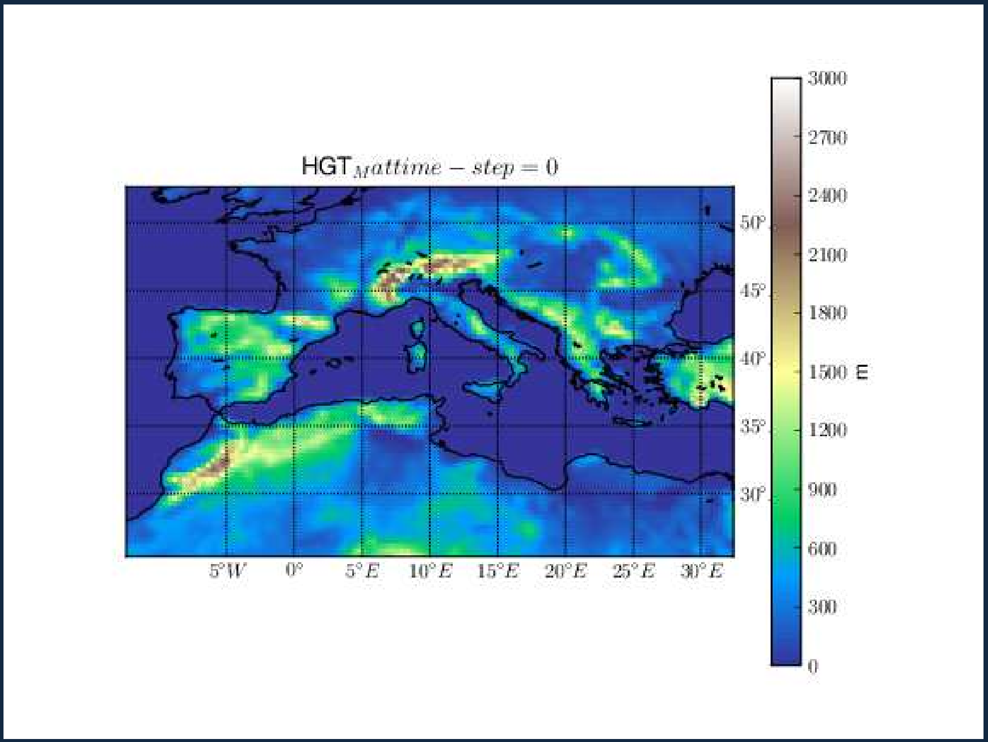

– dimensions: $130 \times 80 \times 39$
– resolution (equator): $0.35°, 0.35°$
– projection: regular lat-lon
– domain center: $N\ 39.0°, 10°$

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- 4 different cases (preliminary results from 3 here presented)

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case	**simulation period**	**description**
Superstorm[a]	10-12/xi/2001	strongest W cyclone *[Fita, 2007, Ann. Geo.]*
medic950116[a]	13-18/i/1995	1995 medicane *[Fita, 2007, NHESS]*
Cévennes96[a]	17-21/ix/1996	Heavy pr SW France *[Berthou, 2014, QJRMS]*
IOP15	18-22/x/2012	Strong convec. in Valencia and pr in Cévennes

[a] not a HyMeX case

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model	label	pbl	sfc layer	s/lw rad	cu	mp
WRF	control*	1	1	4	1	4
	mp	1	1	4	1	6
	rad1	1	1	3	1	4
	cu1	1	1	4	1	4
	pblsfc1	2	2	4	1	4
	shallow	1	1	4	3	4
WRF+LMDZ	wlmdza	y	y	m	e	-
	wlmdzb	y-w	y-w	m	e-t	-

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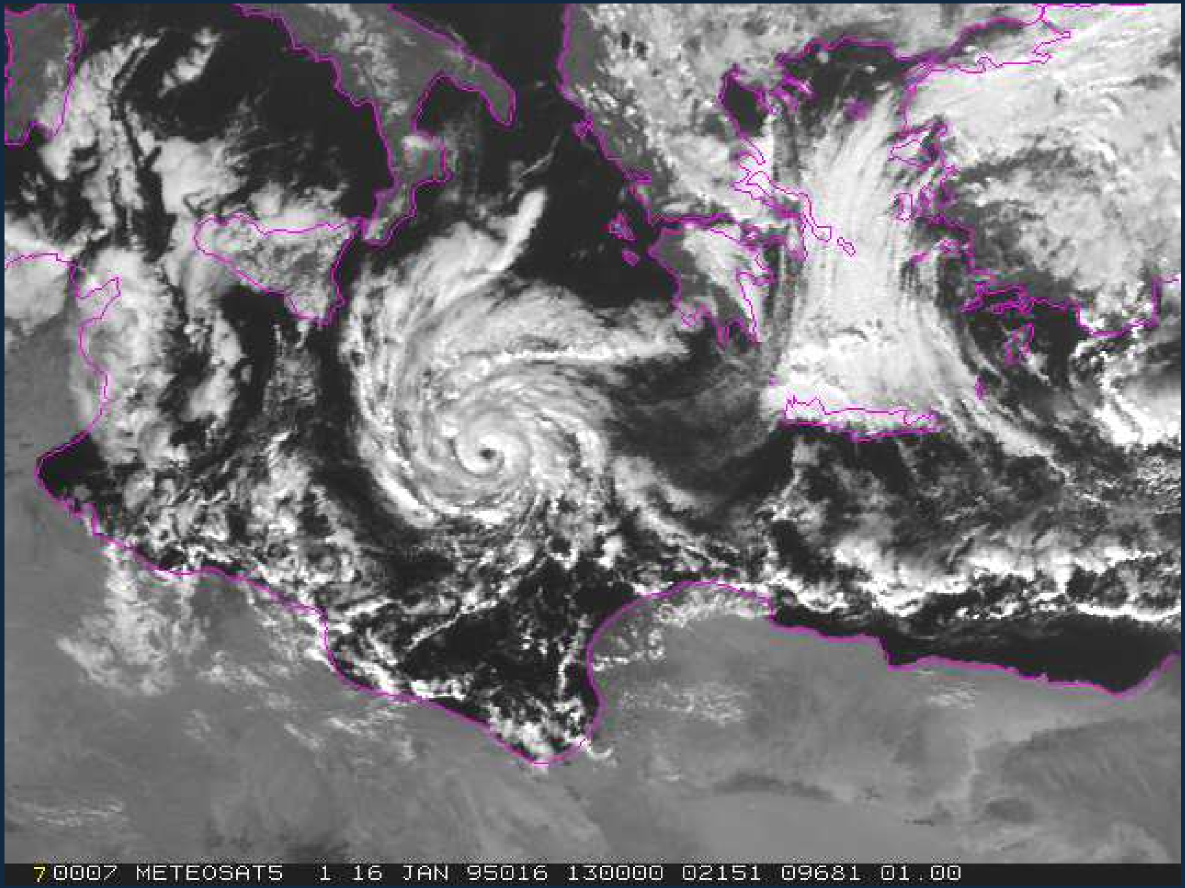

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  - 700 deaths in Algiers, in Majorca island: 1 million trees down, persistent winds up to 30 m/s, 200 mm/day and open-sea waves up to 18m
  - Strong baroclinic environment: upper-level disturbance and surface thermal gradients

Analysis: medicane

- Analysis based on cyclone characteristics

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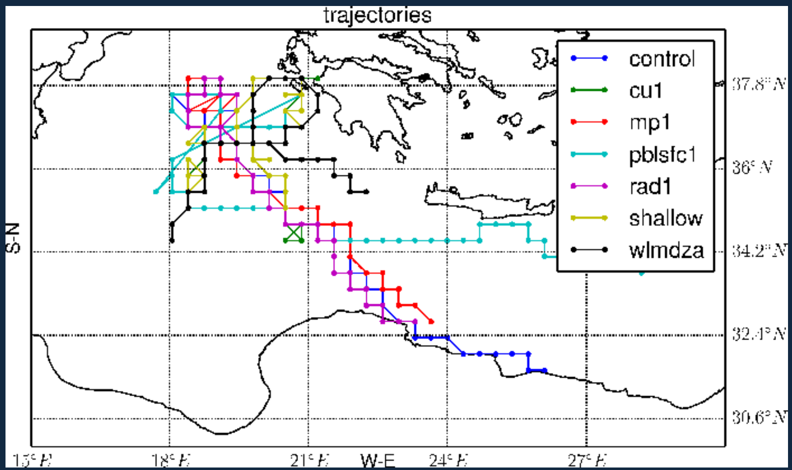
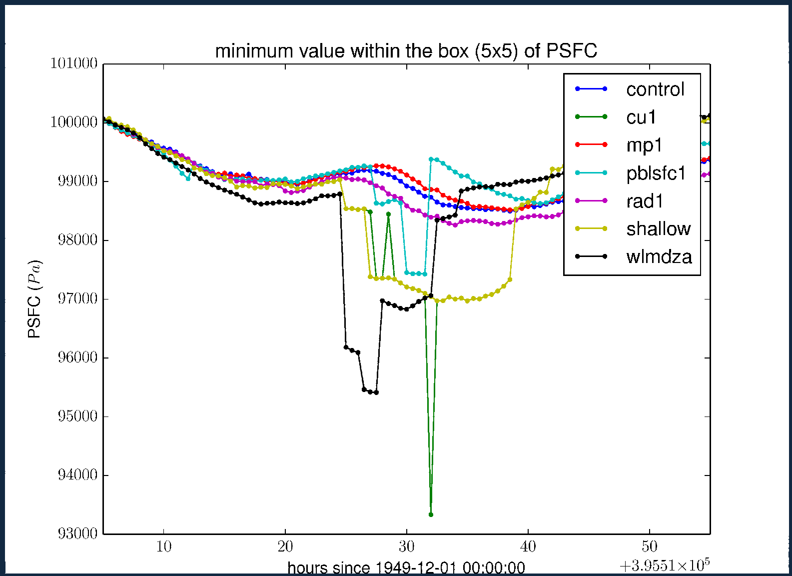
trajectories

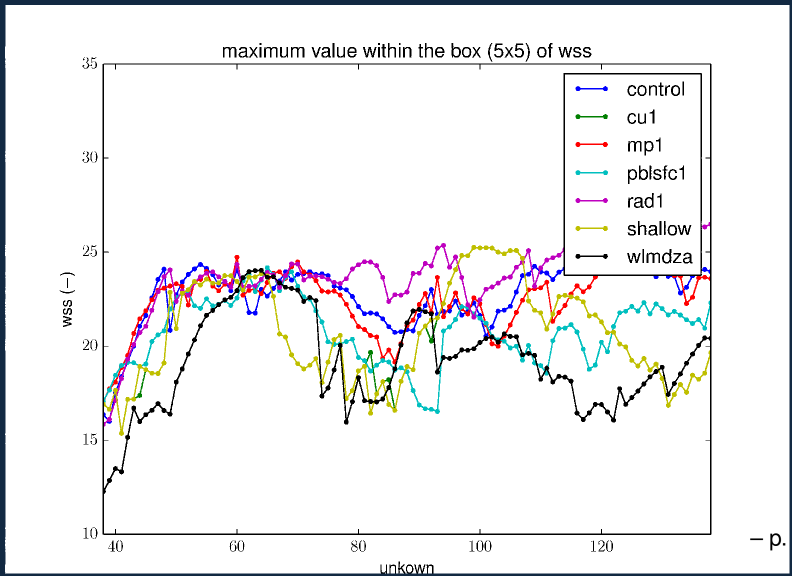


- wlmdza presents a different trajectory and a sooner peak of the cyclone
- similar wind intensity for all the runs

minimum psfc



maximum wind speed



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- Spatial analysis using gridded SAFRAN (*[Quintana-Seguí, 2008, J. Appl. Met. Clim.]* 8k, Météo France) observational dataset

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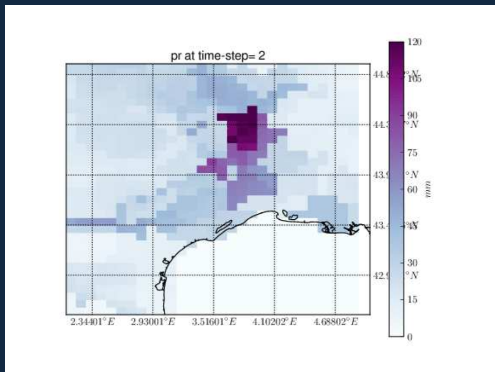
- Analysis on the on 19 Septmber 1996: daily accumulated precipitation

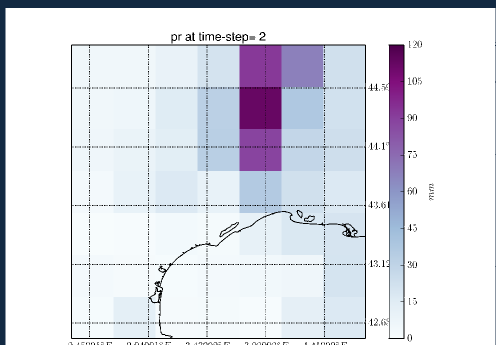
pr Results: Cévennes96

18 September:

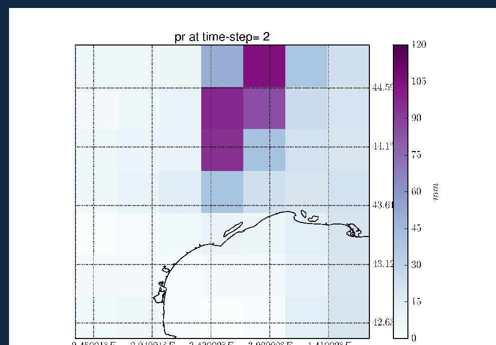


- Miss of wlmdza simulation
- Similar results from all WRF runs
- No difference with shallow cumulus scheme

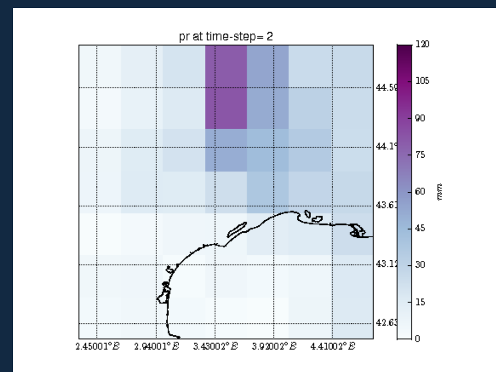
control



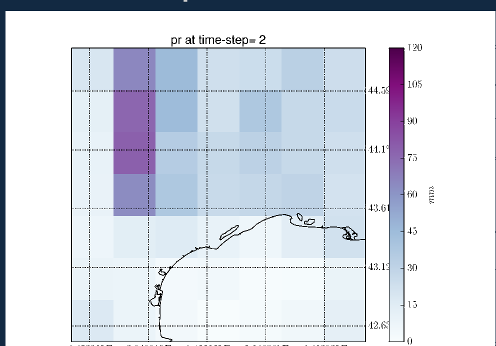
mp1



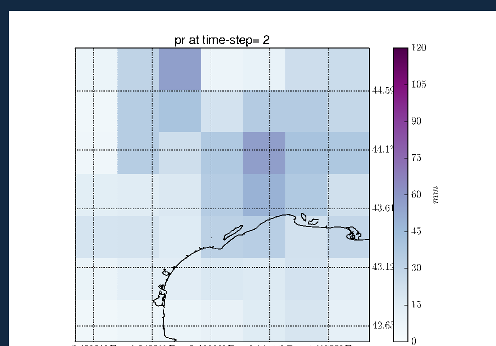
rad1



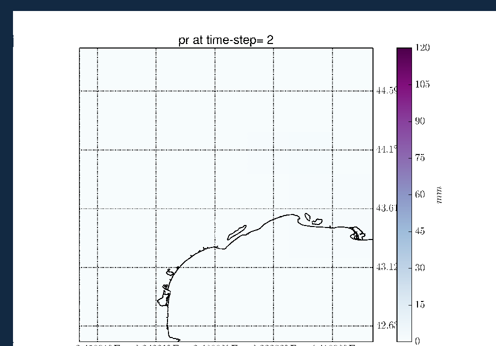
pblscf1



shallow



wlmdza



Analysis: Superstorm

- Station-based analysis using EMAS Spanish operational surface stations (*Agencia Estatial de Meteorología*) in the Balearics (values each 10 minutes)

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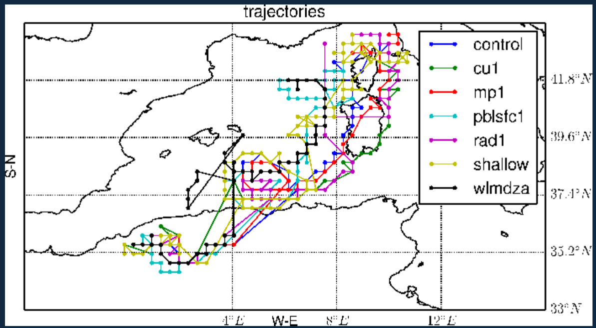

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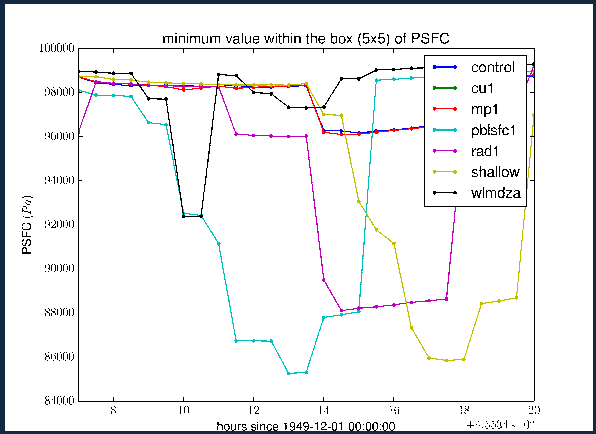
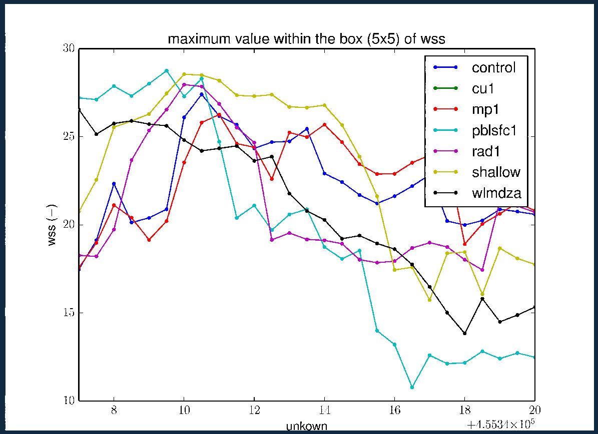
- wlmdza slightly weaker winds

minimum psfc

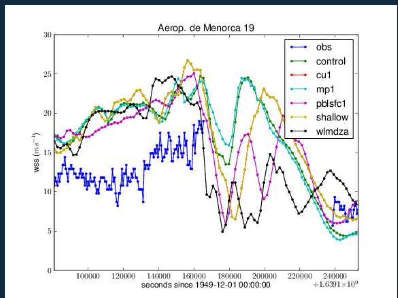


maximum wind speed

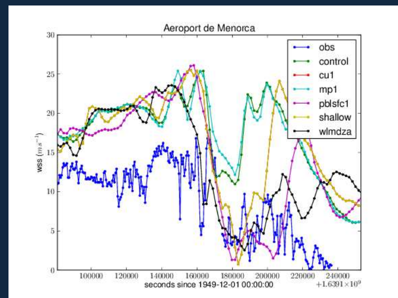


wss Results: Superstorm

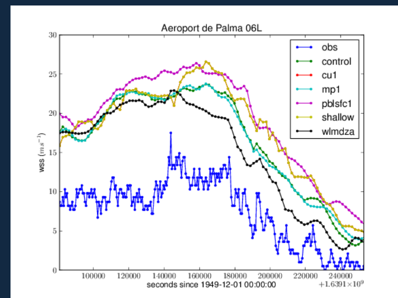
Menorca airport L19



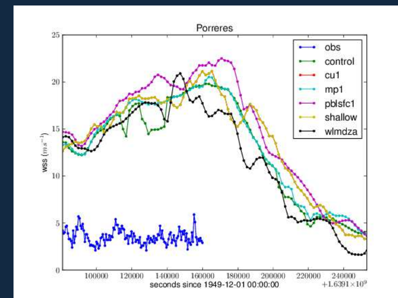
Menorca airport



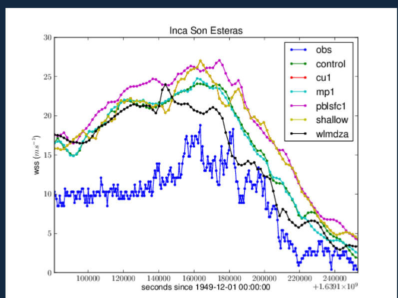
Palma airport 06L



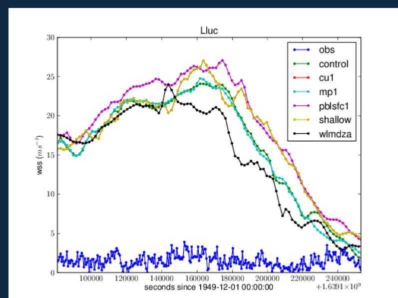
Porreres



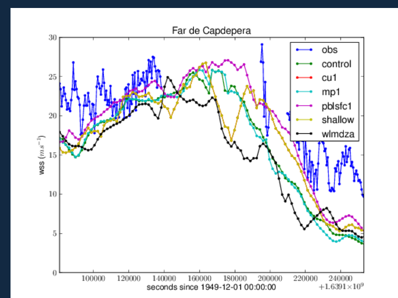
Inca



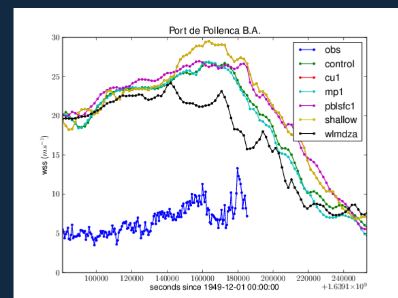
Lluc



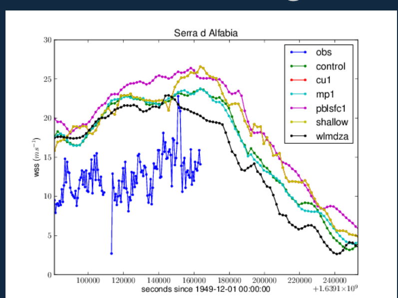
Capdepera Lighthouse



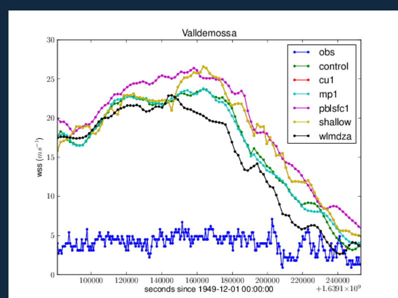
Pollença harbour



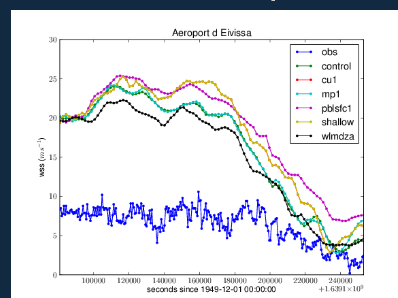
Alfàbia range



Valldemossa



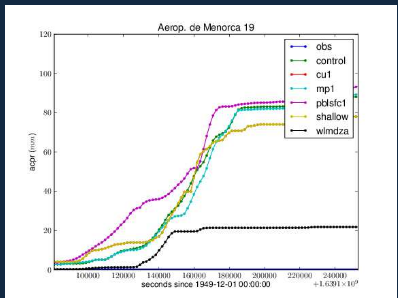
Eivissa airport



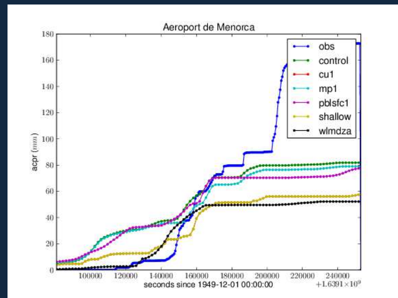
- Wind overestimation (excep. max)
- Similar temporal evolution
- Huge station sensitivity

pr Results: Superstorm

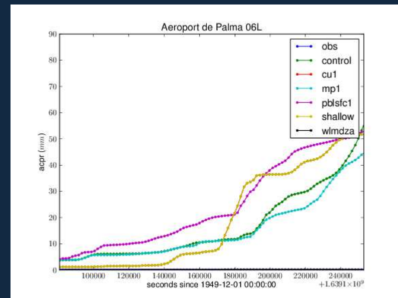
Menorca airport L19



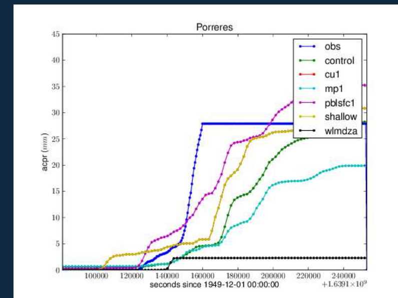
Menorca airport



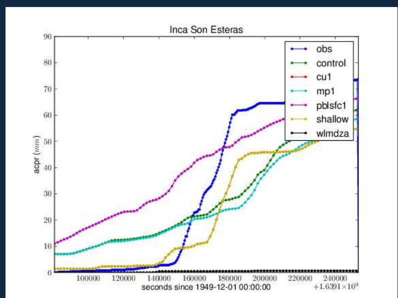
Palma airport 06L



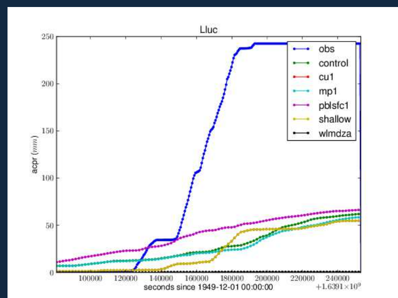
Porreres



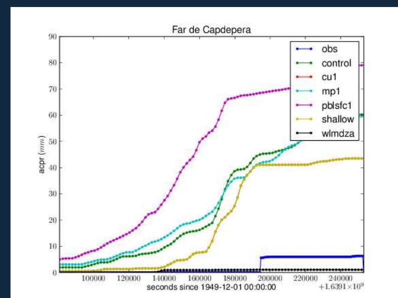
Inca



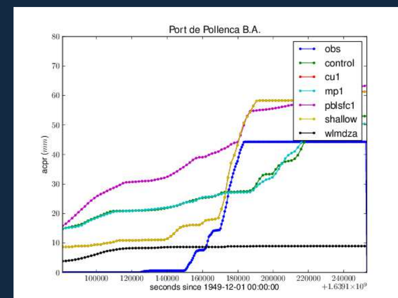
Lluc



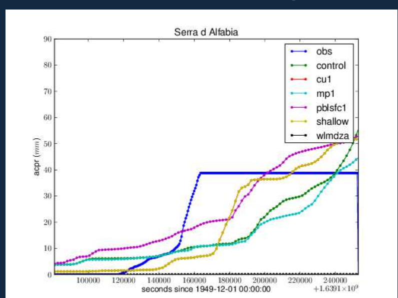
Capdepera Lighthouse



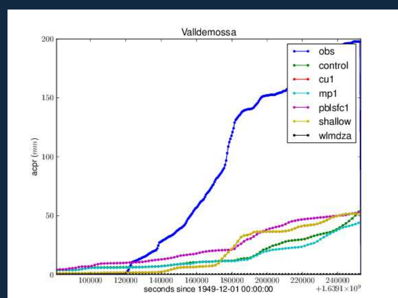
Pollença harbour



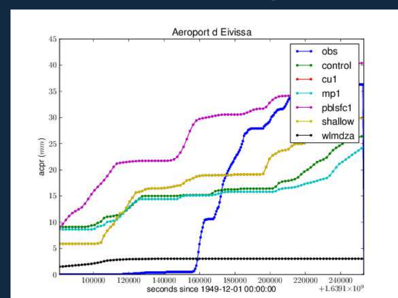
Alfàbia range



Valldemossa



Eivissa airport



- Underestimation of precipitation
- Smoother temporal evolution
- wlmdza too low

Conclusions & Further work

- Integration of LMDZ physics in WRF works!

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- Further work
  - Finish WRF+LMDZ technical aspects: models code upgrade, parallel compilation
  - Improve, enhance and deepen case study analysis with multiple platform observations
  - Analyze system simulated evolutions (cyclone track, convective system formation...)
  - Enlarge case study analysis with other cases

Further steps

- Introduce the component in a multi-coupled system with NEMO, ORCHIDEE,...
- Split LMDZ physics in order to be able to run at higher real non-hydrostatic resolutions
- Perform RCM (medic950116, superstorm) and LES (Cevennes96, iop15) WRF simulations as reference runs for the cases
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Thank you for your attention